

## Aflatoxins

Aflatoxins are poisonous, carcinogenic byproducts of the growth of several species of the mold fungus *Aspergillus*. These byproducts are produced as the fungi grow in feed grains, processed feed and food products. In Maryland, aflatoxins are primarily a problem in corn, but can also occur in other grain crops. Aflatoxins are highly toxic to livestock, poultry and people. Consumption of low concentrations by animals sensitive to aflatoxins can lead to death in 72 hours. In general, at nonfatal levels, the health and productivity of animals fed contaminated feed are seriously impaired. As a result, the Food and Drug Administration (FDA) has set an action level for aflatoxins in corn at 20 parts per billion (ppb). Corn containing aflatoxin levels of 20 ppb or more cannot be sold in interstate commerce and in general should not be fed to young poultry, swine and livestock, or to lactating animals, and must not be milled for human consumption.

### Understanding *Aspergillus* and Aflatoxin Contamination

#### Development in the Field

The development of aflatoxins depends on the infestation and growth of the *Aspergillus* mold in corn. High temperatures and high humidity favor the infection of corn kernels throughout the silks by the *Aspergillus* fungi. In the southeastern United States this environmental condition occurs more frequently and is the main reason *Aspergillus* infections and aflatoxin contamination are more consistently, but not exclusively, a problem in the Southeast. Below-normal soil moisture

(drought stress) has also been found to increase the number of *Aspergillus* spores in the air. Therefore, when drought stress occurs during pollination, the increased inoculum load (spores in the air) greatly increases the chances of infection. Furthermore, drought stress, nitrogen stress and other stresses that affect plant growth during pollination can increase the level of aflatoxins produced by the *Aspergillus* fungi.

In the past, insect injury to the maturing ear of corn was considered a requirement for infection to occur. This is now known to be false. However, insect damage to ears provides wounds that allow *Aspergillus* to more readily infect the kernels. Insects also transport *Aspergillus* spores to the silks and the kernels. Therefore, insect damage, especially during pollination in drought-stressed corn, can increase the occurrence of *Aspergillus* and the levels of aflatoxins.

Several other factors play a role in the development of *Aspergillus* mold and aflatoxin production. Because drought stress plays such an important role, practices that reduce drought stress in plants should reduce the levels of infection and aflatoxin production.

Irrigation has been shown to be very effective in reducing *Aspergillus* infection and aflatoxin development even if done only during pollination. Tillage practices have not been as effective and have only been demonstrated to reduce aflatoxin by subsoiling in areas with hardpans. Occasionally during droughts, hybrids of differing maturities or those planted early will pollinate during periods of reduced- or no-drought stress. This escape of drought may differ from one year to the next.

Time of harvest has also been shown to be important in influencing the occurrence and levels of aflatoxin because *Aspergillus* does not compete well with other molds when corn is above the 20 percent moisture content. Harvesting corn when moisture content is above 20 percent followed by rapid drying to at least a moisture content of 14 percent within 24 to 48 hours of harvest keeps further *Aspergillus* growth and toxin production at a minimum.

## Development in Storage

Mature corn that remains in the field or corn that is stored without adequate drying can be subject to *Aspergillus* growth and aflatoxin production. Temperatures between 80°F and 100°F and relative humidity of 85 percent (corresponding to 18 percent grain moisture) are optimum for growth of *Aspergillus*. Growth of the fungus is poor below 55°F but if the grain is moist enough, toxins can still be produced. However, simply reducing the moisture content to as low as 12 percent does not kill the fungus and does not reduce the levels of toxins that have already been produced. If moisture levels rise again above 12 percent anytime during storage, and temperatures are high enough, then mold growth and toxin production will resume.

## Detecting Aflatoxin Contamination

Once aflatoxin is produced, it is stable. Heat, cold and light do not affect it. It is also colorless, odorless and tasteless, and because of the low concentrations involved and the uneven distribution in grain bins, aflatoxins are difficult to detect.

In the past, elevator operators and buyers used the *blacklight test* but this test simply detects compounds that fluoresce (aflatoxins and others) and should only be used to select samples that require further testing. Similarly, *minicolumn tests* are no longer recommended, as they were prone to give false positive results if used improperly. *Immunology tests* are now considered to be more reliable and their accuracy has been validated by comparison to more costly and time-consuming analytical procedures.

These immunology test kits do not require specialized labs, equipment or training and when conducted according to the instructions can give accurate results.

## Sampling for Aflatoxins

Regardless of the test procedure used, the single most important factor for reliable and accurate testing of grain for aflatoxins is obtaining a representative sample. The ideal sample size should be at least 10 pounds of corn. The sample should consist of many small samples (10 or more 1-pound samples) that have been taken from different spots and then mixed together. Each bin or truck should be handled separately; a 10-pound sample should be taken from each.

Samples should be placed in a container that can breathe (air-tight containers or plastic bags allow condensation which raises the moisture content, resulting in the continued growth and toxin production of the fungus). Samples should be sent or taken to a testing lab as quickly as possible. Thursday through Saturday is not a good time to mail a package. It may be delayed in transit someplace. This gives the fungus a chance to continue to grow and produce toxins. Samples should be properly identified and include: the source of the sample (truck or bin), the sender of the sample and a telephone number.

## Preventing Aflatoxin Contamination

Resistance to aflatoxin accumulation in corn kernels has been recently identified. Resistant hybrids should become available in the near future. Aflatoxin contamination of corn products can be minimized by:

**Reducing plant stress.** Use recommended production practices to minimize plant stress and maximize yields. These include insect, weed and disease control practices, and use of recommended plant populations and fertility practices. If economically feasible, consider the use of irrigation especially during pollination. Plant corn as early as possible, and plant several different hybrids of different pollination periods to reduce the

chance of environmental stress at pollination in at least part of the crop.

**Harvesting corn early and drying it immediately**. Harvesting corn when it is above the 20 percent moisture content and drying it within 24 to 48 hours to at least a moisture content of 14 percent greatly reduces the infection, growth and toxin production by *Aspergillus*

**Avoiding damaged kernels.** Damaged kernels are more likely to become infected with molds both in the field and in storage. Corn hybrid selection and insect control can play a role in reducing kernel damage. Corn hybrids with good husk coverage of the ear have been shown to have less infection and aflatoxin development. Also, Bt corn hybrids based on events that express the Bt trait in the ears and the silks are also less likely to become infected with toxin-producing fungi as a result of reduced kernel damage. Adjustment of the combine to reduce mechanical damage of the kernels at harvest is a very important means of reducing contamination in storage.

**Storing corn at 12 percent moisture content.** Maximum moisture content for storage should be 14 percent. Moisture content at or below 12 percent is ideal for storage of corn because growth and toxin production by *Aspergillus* cannot occur.

**Keeping storage and feeding facilities clean.** *Aspergillus* fungi can survive on residues left in storage areas. When environmental conditions become favorable, infection and toxin production can occur in storage.

## Using Contaminated Corn

**Recommended levels are 0 ppb aflatoxins in feed.** However, aflatoxin-contaminated feed can be tolerated by some animals, particularly older ones. Obviously, the higher the level of contamination, the greater the risk in feeding contaminated corn to animals. Furthermore, continued proper storage is essential so that aflatoxin levels do not continue to increase in the corn or feed before use.

There are no clear-cut safe levels for different animal species regarding their resistance or tolerance to aflatoxins. For those who have

decided to risk feeding aflatoxin-contaminated feeds, the following general guidelines may assist you in your decision making:

- Lactating cows should not receive more than 20 ppb of aflatoxin in the total concentrate of their ration. Calves should not receive milk from cows receiving more than 20 ppb aflatoxin because they can ingest aflatoxin through the milk.
- Beef cattle can tolerate slightly higher levels. Yearlings and mature cows should not receive more than 400 ppb in the total ration. Weaning calves should not receive over 100 ppb in their total ration.
- Poultry and swine are more sensitive to aflatoxin and so are horses. Under no circumstances should they be fed more than 20 ppb aflatoxin.

The above are guidelines; safe levels vary with each individual animal. Remember that ingestion of aflatoxins at levels even lower than those listed in the guidelines may cause some undesirable side effects, and is dependent on such factors as age, sex and general health of the animals. In all cases monitor animal health closely and discontinue the use of contaminated feed immediately if undesirable effects are noticed.

Detoxification of feed is still an elusive goal. However, certain feed additives have been successfully used to inhibit mold growth and to reduce the incidence of aflatoxicosis in animals. Organic acids such as propionic, sorbic and benzoic acids, as well as their salts such as calcium propionate and potassium sorbate, and copper sulfate can be used to inhibit mold growth in feed. Mineral clays such as zeolite and bentonite as well as hydrated sodium calcium aluminosilicate (HSCAS) can bind to aflatoxin, protecting animals from absorbing the toxin that may be in the feed. These products, according to FDA rules, cannot as yet be labeled as mycotoxin binders, and are sold as anticaking and free-flow feed additives.

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